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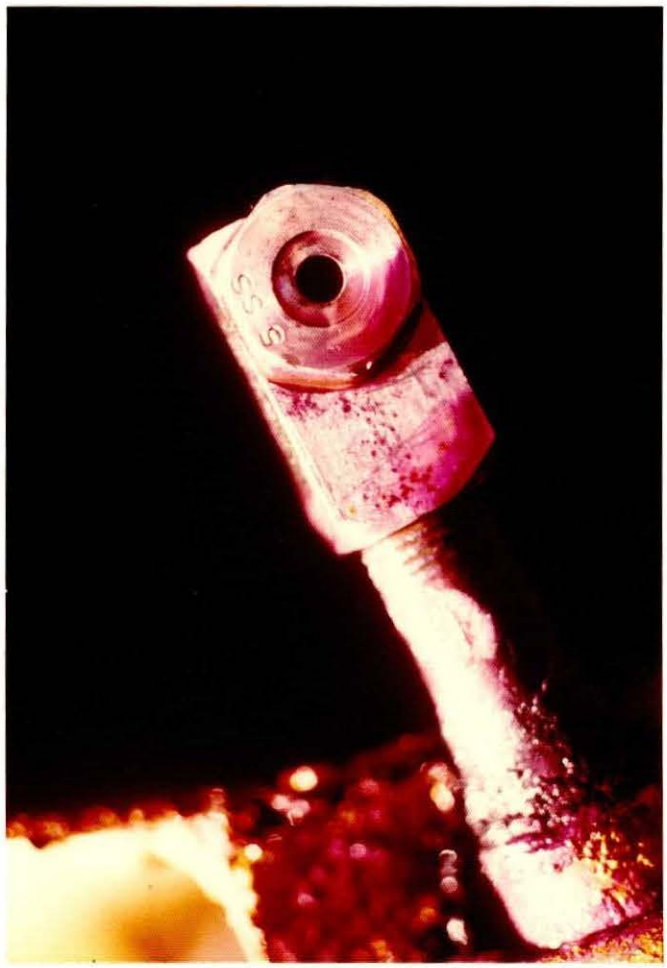
SPRAY EVALUATION OF TWO INTERNATIONAL PAPER COMPANY SEED ORCHARDS
DECEMBER 1978-JANUARY 1979



SOUTHEASTERN AREA, STATE & PRIVATE FORESTRY
USDA FOREST SERVICE, ATLANTA, GA 30309

COVER PHOTO

No. 5SS 1/4" male whirl jet, wide angle hollow cone spray nozzle

SPRAY EVALUATION OF TWO INTERNATIONAL PAPER COMPANY SEED ORCHARDS DECEMBER 1978-JANUARY 1979

By
Larry Barber[1/] and Donna Leonard[2/]

INTRODUCTION

Ms. Suzanne E. Goldman[3/], Entomologist for International Paper Company reported at the 14th Southern Forest Tree Improvement Conference (Goldman, 1977) that Dioryctria spp. (coneworm) damage on four International Paper Company slash pine orchards ranged from 22 percent to 49 percent in 1976 (Goldman, 1977). In 1978, the Gateswood (Bay Minette, Alabama) and Dellwood (Dellwood, Florida) seed orchards were treated with Furadan at 8 ounces per inch diameter (dbh), sprayed with five to six applications of Guthion and one application of Malathion. In spite of these pesticides, coneworm losses on the Gateswood orchard were estimated at 30 percent.

International Paper considered these losses to be excessive and requested assistance in evaluating their insecticide spray program.

No evaluation was requested of the Furadan application as it was thought to be satisfactory. Furadan may have failed to provide insect control in 1978 because of the dry summer. Furadan, being a systemic insecticide, requires sufficient rainfall for translocation.

In December 1978 and January 1979, personnel from the Asheville Field Office, Forest Insect and Disease Management, State and Private Forestry, U. S. Forest Service visited the Dellwood and Gateswood orchards.

METHODS

A spray deposit analysis was made to determine if spray coverage, which is essential for maximum insect control, was satisfactory. Spray cards made from Kromekote® paper were affixed to 12-ounce soft drink cans which were hung from branches in the upper, middle and lower crown of several orchard trees (Fig. 1).

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3/ Research Entomologist, International Paper Company, Northern Forest Research Center, Bangor, ME.

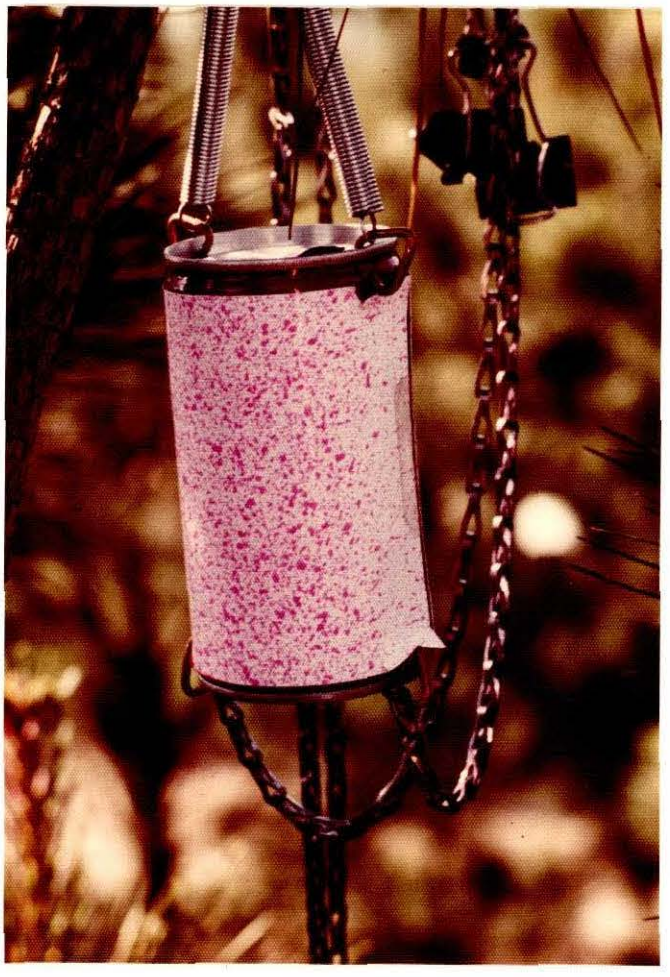

Figure 1. Spray deposit cards on soft drink cans.

Spray equipment at both orchards consisted of super hurricane mist blowers equipped with six 1/4" male whirl jet wide angle hollow cone nozzles (Fig. 2). Nozzle sizes varied between orchards (Appendix I).

The sprayer was filled with 100 gallons of water and one pint Rhodamine BX, a red dye. The sprayer was then driven past the test trees. In all trials both sides of the test trees were sprayed. After visual inspection of spray cards adjustments were made to the sprayers to improve coverage.

Spray volume per tree was determined by measuring tractor ground speed, application time per tree, spray pressure at nozzle and then calculating nozzle flow rates for various nozzle sizes.

Using methods described in Appendix 2, field estimations of spray droplet size (VMD) volume median diameter, were calculated for selected spray cards in each test run.

RESULTS

Gateswood

Spray coverage of the first five trials was unsatisfactory because of equipment malfunctions. Listed below are some of the identified problem areas.

1. Cracked spray nozzle and mixed sizes.
2. Pressure control valve inoperable.
3. Spray boom housing adjustment clamp inoperable.
4. Holes in fan housing.
5. Fan belt slipping.
6. Fan blades too flexible, resulting in reduced air flow.
7. Dented round air discharge nozzle.

After the fifth trial, the sprayer was taken to the shop and the following repairs and/or adjustments were made:

1. Installed six new #15 SS nozzles.
2. Dents in round air discharge tube pounded out.
3. Holes in fan housing repaired.
4. Fan blades replaced.
5. Housing clamp adjusted, giving better control of spray direction and angle.
6. Pressure control valve replaced.
7. Fan belt replaced.

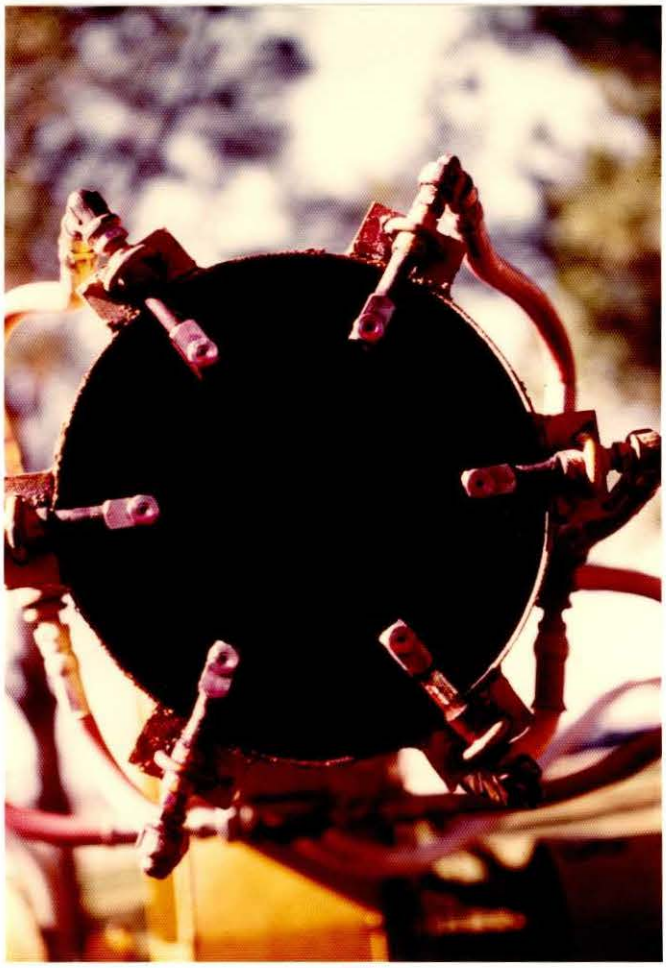

Figure 2. Round air discharge tube with six spray nozzles.

Amount of material applied per tree in trials 1-5 ranged from .3 gallon to 1.3 gallons (Appendix 3). Ground speed in these trials varied from 3.4 mph to 5.8 mph while nozzle pressure ranged from 50 psi to 120 psi. Wind speed was estimated to be less than 5 knots in all tests.

Forest Insect and Disease Management personnel were not present during trials 6-9; therefore, information on ground speed, gallons per tree, and nozzle pressure are not included in this report. Spray deposit cards were sent to the Asheville office for analysis.

In trial one, six #2SS 1/4" male whirl jet, wide angle hollow cone spray nozzles were used. For trials 2-5, these nozzles were changed to a combination of two each of # 2SS, # 3SS, and # 5SS. In trials 6-9, six each of # 15SS were used.

Droplet size (VMD) ranged from 200 to 455 microns (Appendix 3). VMD's in the range of 250 microns are deemed suitable.

Spray coverage was unsatisfactory in trials 1-5 and increased to only marginal in trials 6-9. In those tests, spray coverage was not good at heights above 40 feet.

Dellwood

Amount of spray applied in 1978 applications and in the first trial was estimated at 1 gallon per tree (Appendix 4). Trials 2 and 3 received an estimated 1.53 and 3.06 gallons per tree, respectively.

Tractor/sprayer ground speed was 4 mph in the first and second test run and 2 mph in the third test. Wind speed was estimated to be 10 knots in the first test, 3 knots in the second and 5 knots in the third.

In all three tests, the six spray nozzles were # 5SS whirl jet, wide angle hollow cone 1/4" males. Nozzle pressure was 40 psi in the first test and 90 psi in the second and third tests. A comparison of pressures at the spray nozzle and at the pressure control gauge showed a pressure drop between control gauge and the spray nozzle. For example, a pressure of 120 psi at the control gauge fielded 90 psi at the nozzle.

Droplet size (VMD) was 364, 432, and 352 microns in tests 1, 2 and 3, respectively. Again, a VMD of around 250 microns is preferred.

Spray coverage in test 1 was unsatisfactory because of high wind conditions, i.e., in excess of 10 knots. Tests 2 and 3 were conducted the following morning when wind speed was lower, i.e., 3-5 knots. Correspondingly, spray coverage was much better. Spray coverage in test 3 was superior to tests one and two.

DISCUSSION

"For the best possible coverage of each tree, the nozzles and air discharge should be directed so that approximately 50 percent of the total gallonage goes into the upper one-third of the crown and 70 percent goes into the upper half of the crown. Finally, if maximum coverage is to be acquired, tractor speeds must be kept slow. One mph is often recommended as a good speed for concentrate (mist blown) applications (DeBarr and Merkel, 1969)." Tractor speeds on both orchards were in excess of 1 mph. On the Gateswood orchard, tractor speed ranged from 3.9 to 5.8 mph while on the Dellwood orchard, speeds were from 2 to 4 mph.

This excess speed may be responsible for the less than ideal coverage observed on both orchards. The best coverage observed was on the Dellwood orchard with a speed of 2 mph. As tractor speed is decreased, changes will be necessary in both nozzle size and pressure to keep the spray volume per tree within the Guthion 2S label requirements, i.e., 1-2 gallons. Table 1 and the attached work sheet should be useful in balancing spray pressure and nozzle size.

The proportion of spray reaching the upper half of the crown at the Gateswood orchard on the best of the tests was estimated to be less than 50 percent while the upper third received less than 25 percent. On the Dellwood orchard, we estimated the top half received between 50 to 70 percent of the spray volume in test #3, while the top third received between 30 and 40 percent of the spray deposits.

Slowing the ground speed to 1 mph should show an improvement in spray coverage in the top third of the crown. One reason for this might be better establishment of the air blast column to carry the spray to the top of the tree.

Adequate spray deposits are essential in the upper crown because this is where most of the cone crop is produced.

The amount of spray applied in 1978 was about 1 gallon per tree in both orchards. According to Merkel's and Overgaard's work (Table 2), trees of this height, i.e., 40-50 feet require about 1 1/2-2 gallons of spray to obtain good coverage with a low volume mist blower.

As mentioned previously, a VMD of around 250 microns is deemed satisfactory. The VMD measurements on the Gateswood orchard after the fan blades were replaced dropped into the range of 200 to 263 microns even though nozzle size was increased. In comparison, the VMD's on the Dellwood were between 352 and 432 microns. The Dellwood orchard sprayers' fan blades should be checked and replaced if they are found to be too flexible. This should increase the air speed, returning it to 180 mph (the manufacturer's specification). Correspondingly, the droplet size should decrease. Any slippage of the fan belts will reduce air speed, so the belts should also be checked.

Both orchards presently use Guthion 2L. Mr. Connie Garner in his letter (Appendix 5) points out that the active ingredients may crystalize and settle out if the material is stored at temperatures below 55°F. An alternative to Guthion 2L is 2S which will not settle out at temperatures below 55°F. A second alternative is Guthion 50 percent W.P. which is registered for coneworms and seedworms on slash pine. The label requires 3 pounds per 100 gallons of water. For the size of your trees, you should apply the spray at 1.5 gallons/tree.

The chief advantage of Guthion 50 percent W.P. over the liquid concentrations is that it seems to resist weathering better than liquid formulations in laboratory studies.

The disadvantages of using the 50 percent W.P. formulation is that it is much more difficult to keep in suspension. On some sprayers, special agitation equipment is needed.

Orchard managers often use spreader stickers as an aid in increasing spray deposition. Dr. Jack Nord[4/] (personal communication) has found that the addition of spreader stickers is not warranted.

RECOMMENDATIONS

1. Change Guthion insecticide formulation from 2L to 50 percent W.P. in slash pine seed orchards. Follow label recommendations. However, first check with the manufacturer to determine if your equipment is suitable to handle wettable powders. If not, use the 2S formulation. Do not use Guthion 2L.

2. Continued use of Malathion from thrips control on slash pine is recommended.

3. Check fan blades for excessive flexing. Compare old blades with a new blade. Replace blades if flexing is excessive (Dellwood only).

4. Reduce sprayer ground speed to 1 mph.

5. Apply 1 1/2-2 gallons of spray per tree (mist blower). Use the label spray dilutions.

6. Retest spray equipment using recommendations 3, 4, and 5 to see if coverage of the upper crown increases.

7. If spray coverage cannot be obtained in the upper crown, we recommend the purchase of a more powerful sprayer.

8. The use of spreader stickers is not recommended.

4/ Research Entomologist, SEFES, FSL, USDA. For. Serv., Athens, GA.

APPENDIX I

BACKGROUND INFORMATION FOR INTERNATIONAL PAPER COMPANY
GATESWOOD SEED ORCHARD, BAY MINETTE, ALABAMA AND DELLWOOD SEED ORCHARD, DELLWOOD, FLORIDA

SPRAY DEPOSIT EVALUATION

Parameters	Dellwood Orchard	Gateswood Orchard
Spray Evaluation Date	12-78	1-79
Trees/Acre	37	37
Row Spacing	30	30
Tree Spacing	30	30
Tree Species	Slash Pine	Slash Pine
Tree Height (Max.)	45-50'	45-50'
Sprayer Type	Super Hurricane Mist Blower	Super Hurricane Mist Blower
Application Rate pump Max. Gal./Min.	25 Gal./Min.	25 Gal./Min.
Fan Air Speed - Max.	180 mph at 1825 RPM	180 mph at 1825 RPM
Chemical	Guthion 2L[1/]	Guthion 2L[1/]
Spray Mix	4.1 Gal./100 Gal. Water	4.1 Gal./100 Gal. Water
Sides of Tree Sprayed	2	2
Applications/Year	5-6	5-6
Orchard Estimate of Guthion/Tree[2/]	1 Gal.	3/4-1 Gal.
Spray Concentration	1.09 Percent	1.09 Percent
Label Recommended Rate	1 Percent	1 Percent

1/ Malathion also used to control thrips.

2/ Amount sprayed in 1978 and in first trial of spray evaluation.

APPENDIX II

FIELD ESTIMATION OF VOLUME MEDIAN DIAMETER[1/]

The procedures outlined are for the field estimation of the volume median diameter (VMD) are based on the approach suggested by B. Maksymiuk (1964). Althouth Maksymiuk tested his approach using propeller-driven slow and medium speed aircraft and oil-based sprays, recent experience indicates the method is also adequate for the field estimation of VMD's for seed orchard equipment and sprays.

In the following discussion, it has been assumed that the "stain factor" has been measured prior to the trials. The stain factor is the relationship between the drop size before impaction on the sampling card and the size of the stain produced by the drop on the card. A typical relationship is given by the expression

$$DD = a + b\,(SD) + c\,(SD)^2$$

where

DD = drop diameter

SD = stain diameter

and a, b, and c are constants determined in the laboratory. In the above expression there is no specific provision for the spread of the stain as a function of time after the drop impacts. For some oil-based sprays and some types of sampling cards, the stain can continue to spread for hours after drop impact. When long periods of time are required for stabilization of stain diameters, the analysis of VMD (and perhaps drop density estimation) must either be delayed until stabilization occurs or the time after drop impact be included in the stain factor expression. Also, in the case of long stabilization times, cards may either have to be left on the sampling grid for longer times or special care taken to protect the cards during collection from the grid to prevent smudging.

The D-max method for estimating VMD is based on inspection of sampling cards for large diameter stains. In theory, use of the method requires selecting and measuring the largest stain on every card before selecting the five largest drops. In practice, the following procedure is recommended.

(1) Visually inspect the card and select the largest stain appearing on the card.

(2) Measure the stain diameter to the nearest 50 micrometers using the measuring magnifier graduated in 100 micrometer intervals.

1/ Dumbauld, R. K. and J. E. Rafferty. 1976. Field Manual for Characterizing Spray from Small Aircraft. USDA, Forest Service.

(3) If there are several stains nearly as large as the largest stain on the card, measure their diameters.

(4) Proceed to the next card and repeat the measurement procedure.

(5) Using the stain factor, compute the drop diameter for the largest stains on each card. A battery-operated pocket calculator is recommended for use in making this calculation.

(6) Select the five largest drop diameters from the tabulated values and enter their card numbers and diameters in the spaces provided on the form; enter the largest diameter at the top and the smallest diameter at the bottom. If two or more drops are the same size, they should still be counted as separate drops and listed sequentially in the "Five Largest Drops" table.

(7) The largest drop appearing in the "Five Largest Drops" table is used in the next step to estimate the VMD for the trial, providing that the difference in diameter between any two successively ordered drops does not exceed 32 micrometers. If a difference in diameter greater than 32 micrometers occurs between any of the drops, the drop just below the 32-micrometer gap is used in the next step.

(8) The VMD for the trial is estimated by dividing the drop selected in Step (7) by a factor of 2.2. Enter the VMD in the space provided.

(9) A VMD may be calculated either for individual cards or for one entire trial.

FIELD CHARACTERIZATION OF VOLUME MEDIAN DIAMETER (VMD)

Trial Number _____

Time/Date _____

Row/Line Number _____

Sprayer Type _____

Number of Nozzles _____

Nozzle Type (Cone & Disk) _____

Spray Material _____

Flow Rate _____

Miscellaneous _____

Stain Factor Constants a _____

b _____

c _____

Stain Factor Relationship:

$DD = a + b\,(SD) + c\,(SD)^2$

DD = Drop Diameter

SD = Stain Diameter

Largest Stains and Drops

Card Number	Stain Diameter	Drop Diameter DD = SD/2

Rhodamine Stain Factor = 2

Five Largest Drops	
Card Number	Drop Diameter

VMD = DD/2.2

VMD = _____

APPENDIX III

SUMMARY OF TEST PARAMETERS, INTERNATIONAL PAPER COMPANY, GATESWOOD ORCHARD, BAY MINETTE, ALABAMA
JANUARY 1979

Parameters	Trials								
	1	2	3	4	5	6	7	8	9
Date	1/17/79	1/17/79	1/18/79	1/18/79	1/18/79	2/13/79	2/13/79	2/13/79	2/13/79
Wind Speed (Knots)	Less than 5								
Sprayer	Super Hurricane Mist Blower								
Nozzle Type	1/4" male, whirl jet, wide angle hollow cone spray nozzles								
Nozzle Total Numbers	6	6	6	6	6	6	6	6	6
Nozzle Size	6 #2SS	2 #2SS 2 #3SS 2 #5SS	2 #2SS 2 #3SS 2 #5SS	2 #2SS 2 #3SS 2 #5SS	2 #2SS 2 #3SS 2 #5SS	6 #15SS	6 #15SS	6 #15SS	6 #15SS
Pressure at Control Gauge (PSI)	50	100	90	120	90	20	40	30	30
Pressure at Nozzle (PSI)	53	105	85	120[2/]	85	___	Unknown	___	___
Application Gallons/Tree (Calculated)	.3 gal/tree	1.3 gal/tree	.7 gal/tree	.9 gal/tree	1.05 gal/tree	___	Unknown	___	___
Tractor RPM[1/]	1250	1600	1800	1800	1800	1900	1900	1900	1900
Tractor Gear	2nd	3rd	5th	5th	4th	___	Unknown	___	___
Ground Speed	5.8 mph 8.57' sec.	3.4 mph 5' sec.	5.1 mph 7.5' sec.	5.1 mph 7.5' sec.	3.9 mph 5.7 fps		3.5 mph or 5.13' sec.[2/]		
Sides of tree Sprayed	2	2	2	2	2	2	2	2	2
Dye	Rhodamine BX liquid, 1 pint/100 gal. water								
Sampler	Kromekote paper on soft drink cans								
Sticker	None								
Droplet Size VMD	284	341	455	432	409	364	236	263	200
Coverage (Visual Est.)	- - - - - - - - - -Unsatisfactory- - - - - - - - - - -					- - - - - - - - -Marginal- - - - - - - - -			

1/ Pressure control valve was inoperable, therefore, tractor engine speed was the only regulation of pressure.

2/ Estimated.

APPENDIX IV

SUMMARY OF TEST PARAMETERS, INTERNATIONAL PAPER COMPANY
DELLWOOD ORCHARD, DELLWOOD, FLORIDA
DECEMBER 1978

Parameter	Trials		
	1	2	3
Date	12/12/78	12/13/78	12/13/78
Wind Speed, Knots	10	3	5
Sprayer	Super Hurricane Mist Blower		
Nozzle Type	1/4" male, whirl jet, wide angle hollow cone spray nozzles		
Total No. Nozzles	6	6	6
Nozzle Size	# 5SS	# 5SS	# 5SS
Pressure at Control Gauge	50	120	120
Pressure at Nozzle	40	90	90
Calculated Actual Galls./Tree	1.02 gal./tree	1.53 gal./tree	3.06 gal./tree
Tractor RPM	1800	1800	1800
Tractor Gear	5th	5th	4th
Ground Speed	5.88'/sec. or 4 mph	5.88'/sec. or 4 mph	294'/sec. or 2 mph
Sides of Tree Sprayed	2	2	2
Dye	Rhodamine BX liquid, 1 pint/100 gallons of water		
Sampler	Kromekote paper on soft drink cans		
Sticker	none	none	none
Droplet Size, VMD	364	432	352
Coverage (Visual Estimate)	Unsatisfactory	Marginal	Satisfactory

Chemagro

Agricultural Division

Mobay Chemical Corporation

P.O. Box 4913
Hawthorn Road
Kansas City, MO 64120

Cable: Kemagro Kansas City
Telephone: 816/242-2000

April 5, 1977

Mr. Larry R. Barber
USDA - Forest Service
P. O. Box 5895
Ashville, North Carolina 28803

Dear Larry:

I was glad to have the opportunity to visit with you by telephone March 29th, concerning the use of GUTHION for control of seed cone insects in seed orchards.

As I mentioned, Jack Barry of Davis, California, called me a few days ago and stated you had been in touch with him by phone and planned to work out a program this Spring to try to determine the reason for erratic results with GUTHION in 1976. After discussing this matter with you, I am inclined to agree that one problem might be in application.

I also mentioned I would send labels for GUTHION 2L and GUTHION 2S Emulsifiable Insecticide. We discussed the storage qualities of both formulations and I pointed out the GUTHION 2L had the statement on the label, "Do not store below 55° F." Physical properties of this formulation were much better a few years than they are now. We feel due to the energy situation, we are now getting a different type of solvent system than we were able to obtain a few years ago.

There could be a problem in using GUTHION 2L early in the season, especially if the temperature of the material is 55° F. or below. At above 55° F. or below, the material crystallizes and will separate out from the solvent system. I discussed this matter with Jack Barry and told him this could possibly be one problem if the material was applied early in the season at rather cold temperatures. However after discussing this matter with you, I am inclined to think other factors might be involved and be responsible for the erratic control with GUTHION this past season.

You mentioned there may be a meeting set up between you, Jack Barry and others in South Carolina some time about April 20th, in order to discuss the total cone insect control program in pine seed orchards. I would appreciate you and Jack keeping me informed of this possible meeting as I sure would like to attend if my schedule permits.

Within the past few years, U.S. Forest Service has devoted quite a lot of time and effort in supplying information to register GUTHION for control of seed cone insects in pine seed orchards. In all of the test work I have seen, GUTHION performed very satisfactorily. We are very interested in working with you and other members of the Forest Service to try to work out the very best program possible where GUTHION can be used successfully in seed orchards for control of cone seed insects.

Looking forward to working with you and your group on this particular project. In our meeting, we can discuss in detail some suggestions on how to heat GUTHION containers in order to get the material back into solution as quickly as possible.

Regards,

C. F. Garner, Coordinator
Federal & State Projects

CFG:ss

Enclosures

cc: Mr. John W. Barry w/att

Table 1. Spray delivery rates in gallons per minute per nozzle of 1/4-inch whirl jet wide angle hollow cone nozzles at various pressures.

	Nozzle Pressure Measured in Lbs./Sq. In.							
Nozzle Size	10 psi	20 psi	30 psi	40 psi	60 psi	80 psi	100 psi	120 psi
2SS	.2	.28	.35	.4	.48	.56	.63	.70
3SS	.3	.42	.52	.6	.73	.85	.95	1.05
5SS	.5	.7	.86	1.0	1.2	1.4	1.6	1.8
10SS	1.0	1.4	1.7	2.0	2.5	2.8	3.2	3.6
15SS	1.5	2.1	2.6	3.0	3.7	4.2	4.7	5.3

Table 2. Gallons of spray required per tree on seed orchard trees.

Tree Species	No. Trees Sprayed	Average Tree Hgt. (Ft.) (Range)	High Volume Drench Gal./Tree (Range) (6 Pts./100 Gals.)	Low Volume Mist/Blower Gal./Tree 30 Pts./100 Gal. (5x)
		Overgaard's Work		
Loblolly	8	28.6 (25-34)	3.78 (2.52-7.98)	0.76 (3/4)
Shortleaf	5	23.6 (21-24)	2.56 (2.10-3.15)	0.51 (1/2)
Loblolly	10	20.2 (18-23)	1.70 (1.47-2.39)	0.34 (1/3)
Shortleaf	5	15.2 (13-18)	0.97 (0.63-1.68)	0.19 (1/4)
		Merkel's Work		
Longleaf		55'		2.00
Slash		40'	8	

SPRAY DELIVERY RATE WORKSHEET

Orchard Name _____ Tree Species _____

Desired Gallonage Per Tree _____ Tractor Speed = $\frac{\text{Distance Traveled (Ft.)}}{\text{Time (Sec.)}}$ = Ft./Sec.

Tree Spacing in Row _____

Total Tree Application Distance
(Tree Spacing x 2) _____

DELIVERY RATE COMPUTATION

Application time per tree (sec.) = $\frac{\text{Total Tree Application Distance}}{\text{Tractor ground speed (ft./sec.)}}$

Total gallons per minute (GPM) = $\frac{\text{Total desired gallonage per tree}}{\text{Application time per tree (sec.)}} \times 60$

GPM per nozzle = $\frac{\text{Total GPM}}{\text{\# of nozzles}}$

Using Table I, a corresponding nozzle size and pressure can be found for any desired GPM per nozzle.

LITERATURE CITED

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